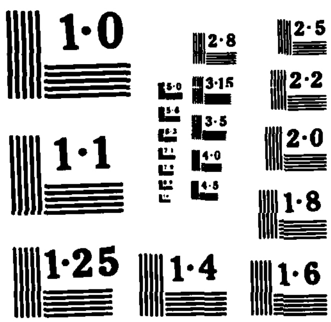
AD-A163 104 SUPER-ACTIVE REGIONS AND PRODUCTION OF MAJOR SOLAR FLARES(U) STANFORD UNIV CA CENTER FOR SPACE SCIENCE AND ASTROPHYSICS T BAI OCT 85 CSSA-ASTRO-85-24 1/1

UNCLASSIFIED N00014-85-K-0111 F/G 3/2 NL

END

FILMED

DTIC


1·0
2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
1·8
1·25
1·4
1·6

AD-A163 104

(12)

C S S A

SUPER-ACTIVE REGIONS AND
PRODUCTION OF MAJOR SOLAR FLARES

Taeil Bai
Center for Space Science and Astrophysics
Stanford University

CSSA-ASTRO-85-24
October 1985

LELAND STANFORD JUNIOR UNIVERSITY ORGANIZED 1891

CENTER FOR SPACE SCIENCE AND ASTROPHYSICS
STANFORD UNIVERSITY
Stanford, California

85 12 9 00

12

SUPER-ACTIVE REGIONS AND
PRODUCTION OF MAJOR SOLAR FLARES

Taeil Bai
Center for Space Science and Astrophysics
Stanford University

CSSA-ASTRO-85-24
October 1985

to be published in
Solar Flares and Coronal Physics
Using Pinhole/Occulter Facility as a Research Tool

edited by
E. A. Tandberg-Hanssen and H. S. Hudson

National Aeronautics and Space Administration
Grant NGL 05-020-272
Grant NAGW-92

Office of Naval Research
Contract N00014-85-K-0111

SUPER-ACTIVE REGIONS AND PRODUCTION OF MAJOR SOLAR FLARES

Taeil Bai
Center for Space Science and Astrophysics
Stanford University

The success of imaging detectors with small fields of view such as HXIS or the Pinhole/Occulter Facility (P/OF) depends strongly on the ability tc point to the right place at the right time. During solar maximum years many active regions coexist on the solar disk. Therefore, in order to point the imaging detector to the right place, it is important to know which active region is most likely to produce major flares. This knowledge is also important for flare prediction.

As a first step toward this goal, I have identified active regions that produced major flares observed by the Hard X-Ray Burst Spectrometer (HXRBS) on SMM from 1980 February through 1983 December. For this study I used the HXRBS Event List (Dennis et al. 1983), an updated flare list compiled by the HXRBS group, and the Comprehensive Reports of the Solar Geophysical Data. During this period, HXRBS detected hard X-rays from ~ 7000 solar flares, of which only 440 flares produced X-rays with peak count rates exceeding 1000 counts/s. Such flares with such high peak count rates may be considered major flares. During the same time period about 2100 active regions passed across the solar disk, of which only 153 active regions were observed to produce major flares. (Some active regions are known to persist for several solar rotations; but at each passage new active region numbers are assigned, and my estimate is based on active region numbers.) Of these 153 active regions, 25 were observed to produce five or more major flares. Considering their substantial production of major flares, we may call these active regions "super-active regions." These 25 super-active regions produced 210 major flares, accounting for 52 per cent of all major flares with identified active regions.

Table I shows several active regions as a function of observed major flares. Eighty-two active regions produced only one major flare each during SMM observation period, and several active regions are found to produce more than 10 major flares. Because SMM is in the Earth's shadow approximately 50 percent of the time, the actual rates should be regarded as about double the rate shown in this table. In Table II super-active regions are listed chronologically, showing some pertinent parameters. Active region 18405 (NOAA region number 3763) produced the largest number (18) of major flares, making 1982 June the most active month in terms of major flare production. During the same month active region 18422 (NOAA region number 3776) produced 15 major flares, and it was still very active during its next passage across the disk (active region number 18474; NOAA region number 3804), producing 13 major flares. One could learn a great deal about solar flares by studying such super-active regions in detail using magnetograms and optical observations. If there were some common properties among the super-active regions shown in Table II, this would also assist in understanding flare production.

Inspection of the Carrington longitudes of the super-active regions in Table II reveals that the super-active regions are clustered in the 60-120 degree and 300-360 degree intervals and that no super-active regions are found in the 0-30 degree and 210-270 degree intervals.

TABLE I. NUMBER OF MAJOR FLARES PER ACTIVE REGION

Number of Major Flares from Single Active Region	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number of Active Regions	82	29	12	5	7	3	3	4	1	1	1	1	1	0	1	1	0	1

TABLE II. CHARACTERISTICS OF SUPER-ACTIVE REGIONS

ORDER	HALE (NOAA) REGION NUMBER	NO. OF MAJOR FLARES(a)	NORTH OR SOUTH	CMP DATE	CMP DAYS AFTER 00 UT 80.1.1	ROTATION	CARRINGTON LONGITUDE
1	16747 (2372)	8 (0)	N	80 APR 7.3	97.3	New	103
2	16923 (2522)	5 (0)	S	JUN 23.3	174.3	1,2; 16864	166
3	16978 (2562)	6 (1)	S	JUL 17.3	198.3	New	207
4	17244 (2776)	11 (3)	N	NOV 6.6	310.6	2nd: 17181	165
5	17255 (2779)	16 (2)	S	NOV 11.6	315.6	2nd; 17188	100
6	17491 (2958)	6 (2)	S	81 MAR 2.8	426.8	New (b)	74
7	17590 (3049)	7 (2)	N	APR 20.7	475.7	2nd; 17535	150
8	17751 (3221)	5 (1)	S	JUL 24.2	570.1	3rd; (c)	340
9	17760 (3234)	9 (2)	S	JUL 28.3	574.3	2nd; 17713	290
10	17777 (3257)	7 (2)	S	AUG 10.0	587.0	1,2; 17737	118
11	17824 (3310)	5 (0)	S	SEP 4.9	612.9	2nd; 17777	133
12	17830 (3317)	10 (3)	N	SEP 10.6	618.6	New	59
13	17906 (3390)	12 (3)	S	OCT 14.3	652.3	New	334
14	17969 (3432)	5 (0)	S	NOV 4.9	673.9	New at 17890	50
15	18176 (3576)	5 (1)	S	82 FEB 1.4	762.4	New	323
16	18201 (3594)	5 (0)	S	FEB 10.7	771.7	2nd; 18142	202
17	18280 (3659)	8 (1)	N	MAR 29.0	818.0	New	309
18	18405 (3763)	18 (6)	S	JUN 8.5	889.5	New	85
19	18422 (3776)	15 (3)	N	JUN 18.8	899.8	New (d)	310
20	18430 (3781)	8 (1)	N	JUN 21.5	902.5	New	276
21	18474 (3804)	13 (4)	N	JUL 15.0	926.0	2nd; 18422	320
22	18473 (3814)	8 (0)	N	JUL 15.5	926.5	4,5; 18421	314
23	(3994)	7 (1)	S	NOV 20.0	1054.0		72
24	(4026)	5 (3)	S	DEC 16.9	1080.9	2nd; 3994	80
25	(4171)	6 (2)	S	83 MAY 13.0	1228.0		298

Notes:
(a) Numbers in parentheses in this column represent numbers of flares with HXRBS peak rates > 10,000 counts/s.
(b) New at location of active regions 17436 and 17438.
(c) Third rotation. At previous rotations active regions numbers 17709 and 17667 were assigned.
(d) New at lcation of active regions 18382 and 18383.

It has been suggested that there exist active longitudes where the probability of active regions producing interplanetary protons is much higher than for other areas (Svestka 1970; for a review see Svestka 1976). The present study confirms the existence of active longitudes. Recently Gaizauskas et al. (1983) have shown that many active regions frequently

occur in "complexes of activity," which rotate at approximately the Carrington rate. According to Svestka's (1970) study, there was only one sector of active longitudes from 1963 through 1967. However, in the present study we find two sectors of active longitudes whose medians are separated by about 120 degree. The existence of active longitudes may be due to giant convection cells (McIntosh and Wilson 1985).

Because the Carrington rotation period is not the rotation period of the Sun, one can determine the mean rotation rate of the sectors of active longitudes by the following procedure. Adopt a system rotating rigidly at an assumed rate, count the number of major flares occurring in 20 degree longitude bins in this system, and calculate the rms flare numbers. Then by changing the rotation rate around the Carrington rate, find the rotation rate that maximizes the rms value. Using this procedure I found that the rotation period of 27.34 days (synodic) maximizes the rms value. The number of major flares in 20 degree longitude bins in the system rotating with the 27.34 day period is shown in Table III.

TABLE III. NUMBER OF MAJOR FLARES PER LONGITUDE BIN

LONGI-TUDE BIN	0 20	20 40	40 60	60 80	80 100	100 120	120 140	140 160	160 180	180 200	200 220	220 240	240 260	260 280	280 300	300 320	320 340	340 360
NUMBER OF FLARES	20	10	5	9	35	17	78	18	12	7	5	40	60	20	19	19	22	9

Here I have adopted the Eastern limb at 00 UT on 1980 January 1 as 0 degrees. We can see that large numbers of major flares occurred in the 120-140 degree and 240-260 degree bins.

In the following I summarize the highlights of the present study that are pertinent for future P/OF observations of solar flares.

is quite important to discover the properties of such super-active regions. When we recognize super-active regions with the aid of such properties (yet to be found), we will have a better chance of detecting major flares by pointing imaging detectors to such active regions.

(2) There exist sectors of active longitudes, where large fractions of major solar flares are produced. Active regions appearing in active longitudes are good objects for imaging detectors.

Acknowledgment. I would like to thank Drs. Brian Dennis and Alan Kiplinger for providing the updated list of HXRBS flares. This research was supported by NASA grants NGL 05-020-272 and NAGW-92 and ONR contract N00014-85-K-0111.

REFERENCES

Dennis, B. R., *et al*. 1983, NASA Technical Memorandum 84998.

Gaizauskas, V., Harvey, J., Harvey, K., and Zwaan, C. 1983, Astrophys. J., 265, 1056.

McIntosh, P. S., and Wilson, P. S. 1985, Solar Phys., 97, 59.

Solar Geophysical Data, 432-488 Part II, 1980-1984 (Boulder, Colorado: U.S. Dept. of Commerce).

Svestka, Z. 1970, Space Res., 10, 797.

Svestka, Z. 1976, Solar Physics (Dodrecht-Holland: Reidel), pp. 247-249.

END

FILMED

2-86

DTIC